investigation that the underground telephones in use had not been designed to give effective transmission in the ambient noise levels. On some telephones it was just impossible either to hear the bell or to make effective communication. Work is now proceeding to develop suitable telephones for use underground. It was also obvious that a great deal of time was wasted on the telephone because men had not been trained to use the phone properly, and, in particular, a great deal of talking time was wasted because people did not identify themselves, or the position from which they were talking. The experiences gained in the investigation are being used in the preparation of a training manual on the use of telephones.

Communication and Control of Military Forces

by

B. D. HANKIN

THE TACTICAL success of military forces clearly depends to a large extent on the way they can be handled relative to those of an enemy. The quick handling of a fighting force by a higher commander depends not only on the speed of their vehicles, but is greatly dependent on the speed and efficiency of the tactical planning and instructions affecting all arms which precedes an operation. It also depends upon the completion of many administrative arrangements to enable the force to move and fight. Communications in the Army exist for providing the commanders and staffs with this tactical and administrative control.

Object.

A military formation must be mobile and flexible and must be self-contained, with its own communications. But if the task of a force such as a division is primarily to fight, the number of men who can be used to provide and maintain communications is necessarily limited both in quantity and quality. Our object was to provide data which would help the War Office to decide how the Royal Signals men and equipment should be employed to the best advantage.

A radio operator is not normally trained to lay telephone lines, a despatch rider does not know how to operate a telephone switchboard. How suitable were the existing proportions and structure of tradesmen and if new methods of communications such as the beam wireless telephone system (known in the Army as "Radio Relay")

was to be introduced, where was the best place from which to take the manpower to operate it?

Method.

We chose the division as our unit for study and most of our work was carried out in armoured divisions in Germany. A division at war consists of about 17,000 men. It is controlled from divisional headquarters where the divisional commander (a major general), and the divisional staff exercise command.

There are two brigades each controlled by a brigade headquarters. To simplify our problem we concentrated on the level of command between division and brigade.

We came to the conclusion that all the stages in mounting and carrying through a successful operation involve the transmission of a commodity we described as "military information".* It is a process which takes place both up and down the chain of command.

The methods of transmitting "military information" which are in use at this level are:—

(a) Personal Contact. *Includes visits by general, liaison officers, order groups and conferences.*
(b) Radio Telephony.
(c) Line Telephony.
(d) Despatch Rider. *Includes written messages, maps and documents.*
(e) Morse Code by Wireless.

We considered that three important things associated with any piece of information were its quantity, urgency and security. Its value to the battle was also important but we decided to concentrate in the early stages on these three and particularly on the quantity.

If we were to compare the quantities of military information carried by the various means we had to find a unit of measurement which could be common to all.† We adopted a unit of our own which we called "Useful Words". This could be common to speech by wireless or telephone and also to written documents. The difficulty of course lay in defining what we meant by "useful". Not without difficulty this definition was formulated: "Words may

* We defined this as: "Any knowledge which is relevant to the prosecution of the war and which reaches the minds of those in control at any level and by any means".

† Shannon and Weaver's Mathematic Theory of Communication introduced a "binary digit" or "bit" as a unit of information. This was considered but rejected as impracticable for the early stages of the study.

be counted as useful if in the circumstances they are judged to have military importance, and if it is considered reasonable that two informed and busy individuals might use them in passing information from one to the other, when seated on opposites sides of a quiet secluded room". This succeeded in excluding all the procedure associated with getting through, chit-chat if found, and repetitions due to the imperfections of the medium.

In order to establish the broad facts as to how a division was controlled we decided to try to measure all the information flow by all means at the division to brigade level on full-scale manœuvres lasting nearly a week. The only completely objective method of doing this is to make recordings of every single radio and telephone transmission and every meeting between staff officers. The time required for analysis of these recordings makes this impracticable. We found a way which was sufficiently accurate for our purposes. By a sampling system we measured the "voice occupancy" of all the radio nets and telephone lines and at the same time made tape recordings of many hours of each. Subsequent analysis of the recordings provided factors with which we could convert "voice occupancy" into useful words. We tackled personal contact flow in the same way. We made recordings of order groups and deduced a factor which could be used to convert the length of the discussion measured in minutes into "useful words". Despatch traffic was dealt with by analysing the contents and noting the flow of typical packages. To do all this in a self-contained manner on a twenty-four hour basis needed a team of about twenty-four men and eight vehicles.

Results.

The results included the following:

(a) Communications depend to a very large extent upon the integration of staff and Signals and upon the standard of training and equipment of both. It is the staff—Signals—equipment combination which produces the results. Search in all three must be made to gain improvement.

(b) The estimated proportion of useful words carried by the various methods between Divisional H.Q. and forward units on the whole 4-day exercise is shown in Table I.

(c) Personal contact was an extremely important method of passing "military information". compared with other methods it ranks very high when conditions allow its use.

(d) Wireless nets were not loaded to their capacity except for very short periods—of all the words spoken by wireless, about one-third could be classed as "military information".

(e) The use of Morse code (on which every Royal Signals wireless operator spends much of his training time) made a negligible contribution to the control of the division on this exercise.

TABLE I

	per cent.	No. of useful words
Personal Contact . . .	56	467,000
Radio Telephony . . .	22	186,000
Telephone . . .	11	87,000
Despatch Rider . . .	11	89,000
Morse Code . . .	Negligible	
	100	

We were able to make a number of recommendations which should help to obtain better control within the division without increases in manpower. Above all we believe that we have stimulated thought which will help the planners to realize what they are getting in terms of information passed and control achieved for the effort expended.

In conclusion I would like to stress that this work was a combined operation in the sense that our team included civilian and military members including military personnel serving in Germany and T.A. officers doing their fortnight's attachment. It would also be wrong not to place it in its perspective by saying that it is only one of a number of communication projects which are being tackled by other members of the Army Operational Research Group.

Communications

by

E. C. WILLIAMS

I PROPOSE to add two specific examples of communication problems, and then to speculate about a possible generalization of "battle" situations.

Radar Reporting.

The first specific example is a study of the capacity of the radar reporting system which was carried out by F. L. Sawyer, L. G. H.